U.S. ATLAS-00-01

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U.S ATLAS Computing Project Management Plan

January 17, 2000

List of Abbreviations

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ACWP	Actual Cost of Work Performed
ALD	BNL Associate Laboratory Director
APM	Associate Project Manager for Physics and Computing
AY	At Year (referring to a dollar value)
BCP	Baseline Change Proposal
BCWP	Budgeted Cost of Work Performed
BCWS	Budged Cost of Work Schedules
BHG	Brookhaven Group
BNL	Brookhaven National Laboratory
CB	ATLAS Collaboration Board
CCB	Change Control Board
CERN	European Laboratory for Particle Physics
CH	Chicago Operations Office
DHEP	Division of High Energy Physics
DOE	Department of Energy
EDIA	Engineering Design, Inspection and Assembly
EDMS	Engineering Data Management System
ES&H	Environmental Safety and Health
HEP	DOE Headquarters Office of High Energy Physics
IB	Institutional Board
IMOU	Interim Memorandum of Understanding
JOG	Joint Oversight Group
LHC	Large Hadron Collider
LHCC	CERN LHC Committee
MOU	Memorandum of Understanding
MRE	Major Research Equipment
NSF	National Science Foundation
PAP	Project Advisory Panel
PBS	Product Breakdown Structure
PCAP	Physics and Computing Advisory Panel
PL	ATLAS Project Leader
PM	U.S. ATLAS Project Manager
PMCS	Project Management Control System
PMP	Project Management Plan
PO	U.S. ATLAS Project Office
QAP	Quality Assurance Plan
R&D	Research and Development
RRB	ATLAS Resource Review Board
SC	DOE Office of Science
SM	U.S. ATLAS Subsystem Manager
TDR	Technical Design Report
TRT	Transition Radiation Tracker
WBS	Work Breakdown Structure

1. ATLAS Objectives

1.1 Scientific Objectives

The fundamental unanswered problem of elementary particle physics relates to the understanding of the mechanism that generates the masses of the W and Z gauge bosons and of quarks and leptons. To attack this problem, one requires an experiment that can produce a large rate of particle collisions of very high energy. The LHC will collide protons against protons every 25 ns with a center-of-mass energy of 14 TeV and a design luminosity of 10^{34} cm^{-2} s^{-1}. It will probably require a few years after turn-on to reach the full design luminosity.

The detector will have to be capable of reconstructing the interesting final states. It must be designed to fully utilize the high luminosity so that detailed studies of rare phenomena can be carried out. While the primary goal of the experiment is to determine the mechanism of electroweak symmetry breaking via the detection of Higgs bosons, supersymmetric particles or structure in the WW scattering amplitude, the new energy regime will also offer the opportunity to probe for quark substructure or discover new exotic particles. The detector must be sufficiently versatile to detect and identify the final state products of these processes. In particular, it must be capable of reconstructing the momenta and directions of quarks (hadronic jets, tagged by their flavors where possible), electrons, muons, taus, and photons, and be sensitive to energy carried off by weakly interacting particles such as neutrinos that cannot be directly detected. The ATLAS detector is designed to have all of these capabilities.

1.2 Technical Objectives

The ATLAS detector is designed to perform a comprehensive study of the source of electroweak symmetry breaking. It is expected to operate for twenty or more years at the CERN LHC, observing collisions of protons, and recording more than 10^7 events per year. The critical objectives to achieve these goals are:

- Excellent photon and electron identification capability, as well as energy and directional resolution.
- Efficient charged particle track reconstruction and good momentum resolution.
- Excellent muon identification capability and momentum resolution.
- Well-understood trigger system to go from 1 GHz raw interaction rate to ~100 Hz readout rate without loss of interesting signals.
- Hermetic calorimetry coverage to allow accurate measurement of direction and magnitude of energy flow, and excellent reconstruction of missing transverse momentum.
- Efficient tagging of b-decays and b-jets.

1.3 Cost Objectives

The current cost estimate is in Appendix 1.

1.4 Schedule Objectives

The major milestones are the May'00 milestone for the first round of prototyping from the Architecture Team, Nov. '00 for a full Project Plan, 2003 for Mock Data Challenges, and 2005 for the start of data taking. Appendix 5 provides a list of the Level 2 Milestones.

2 ATLAS Organization

2.1 Introduction

The U.S. ATLAS Construction Project operates within the context of the internationally funded ATLAS experiment located at CERN. The general responsibilities of the U.S. participants are described in Article VI of the Experiments Protocol signed between CERN, and DOE and NSF. In essence, they have responsibilities for R&D, engineering design, prototyping, fabrication, installation and normal maintenance and operation of detector systems and components as agreed to and described in the IMOU, the MOU, and their addenda. The responsibilities of the CERN management are described in Article VIII of the same Protocol.

The U.S. ATLAS Construction Project is managed by the U.S. ATLAS Project Office, located at Brookhaven National Laboratory (BNL), under the direction of the designated U.S. ATLAS Project Manager (hereafter referred to as the Project Manager or PM). The Project Manager has the principal authority for day-to-day management and administration of all project activities. The Director of BNL, or his/her designee, is responsible for management oversight of the project and DOE and NSF jointly provide requirements, objectives and funding.

2.2 International ATLAS and its Project Management

The large general-purpose LHC experiments rank among the most ambitious and challenging technical undertakings ever proposed by the international scientific community. The inter-regional collaborations assembled to design, implement and execute these experiments face unprecedented sociological challenges in marshaling efficiently their enormous, yet highly decentralized, human and economic resources. The overall ATLAS approach to this challenge is to base most of the ATLAS governance on the collaborating institutions rather than on any national blocks. Thus the principal organizational entity in ATLAS is the Collaboration Board (CB), consisting of one voting representative from each collaborating institution, regardless of size or national origin.

The CB is the entity within ATLAS that must ratify all policy and technical decisions, and all appointments to official ATLAS positions. It is chaired by an elected Chairperson who serves for a non-renewable two-year term. The Deputy Chairperson, elected in the middle of the Chairperson's term, succeeds the Chairperson at the end of his/her term. The CB Chairperson has appointed (and the CB ratified) a smaller advisory group with whom he/she can readily consult between ATLAS collaboration meetings.

Executive responsibility within ATLAS is carried by the Spokesperson who is elected by the CB to a renewable three-year term. The Spokesperson is empowered to nominate one or two deputies (there is presently one) to serve for the duration of the Spokesperson's term in office. The Spokesperson represents the ATLAS Collaboration before all relevant bodies, and carries the overall responsibility for the ATLAS Detector Project.

The ATLAS central management team also includes Technical and Resource Coordinators, both are CERN staff members whose appointments to their roles require CERN management approval. The Technical Coordinator has the overall responsibility for the technical aspects of the detector construction. This includes responsibility for the integration of the ATLAS subsystems and for coordinating the CERN infrastructure, including the installation of the experiment in the surface and underground areas. The Resource Coordinator is responsible for budget and manpower planning, including securing the Common Projects resources, and for negotiating the MOUs with the various funding agencies.

The ATLAS Spokesperson chairs an Executive Board (EB), consisting of high-level representatives of all the major detector subsystems plus the Technical and Resource Coordinators. The Executive Board directs the execution of the ATLAS project according to the policies established by the Collaboration Board.

Each ATLAS subsystem has a Project Leader directly and ultimately responsible for ensuring that the design and construction of the corresponding subsystem are carried out on schedule, within the cost ceiling, and in a way that guarantees the required performance and reliability. Each major ATLAS subsystem is overseen by a technically-oriented Steering Group, with expertise in all the relevant technical areas.

It is understood that the U.S.-ATLAS management must operate within the regulations imposed by the U.S. funding agencies, the funding appropriated by the U.S. Congress, and the terms of the U.S.-CERN Protocol on LHC Experiments. Subject to these limitations, it is expected that the U.S.-ATLAS management implements all decisions taken by the ATLAS Resource Review Board (RRB) and the Collaboration Board. The RRB comprises representatives from all ATLAS funding agencies and the managements of CERN and the ATLAS Collaboration. The U.S. has DOE and NSF representatives. The RRB meets twice per year, usually in April and October.

The role of the RRB includes:

- reaching agreement on the ATLAS Memorandum of Understanding
- monitoring the Common Projects and the use of the Common Funds
- monitoring the general financial and manpower support
- reaching agreement on a maintenance and operation procedure and monitoring its functioning
- endorsing the annual construction and maintenance and operation budgets of the detector

As far as project execution is concerned, decisions by the ATLAS Executive Board (EB) should also be adopted directly or, if not compatible with the U.S. operating procedures, adapted so as to match the EB decision as closely as possible. In the latter case ATLAS management should be consulted and informed about the detailed U.S. implementation.

ATLAS has adopted procedures for quality control and change requests valid for all Collaboration partners. For example, a Product Breakdown Structure (PBS/WBS) structure has been established and a global Engineering Data Management System (EDMS) is used to manage documents pertaining to ATLAS Technical Coordination, the ATLAS Detector, General Facilities, Assembly and Test Areas and Offline Computing. A CERN Drawing Directory (CDD) is used to manage all drawings. It is understood that the U.S. institutions use these management procedures and tools at the same level as all the other ATLAS institutions.

2.3 ATLAS Physics and Computing Organization

The ATLAS Physics and Computing Organization consists of two co-leaders, one is the Physics Coordinator, who is in charge of organizing efforts in the area of physics objects, event generators and benchmark studies. The other is the Computing Coordinator, in charge of coordinating core software activities and overall support functions. The Computer Steering Group (CSG) consists of the Computing Coordinator, who acts as chair, the Physics Coordinator, the Chair of the Quality Control Group, the Offline Coordinators representing each of the subsystems (Inner Detector, TRT, LAr, Tile, Muon, Trigger/DAQ and Event Filter), and the chair of the National Computing Board (NCB).

The National Computing Board (NCB) consists of one representative from each country in the collaboration, and has an elected chair who serves for a two year term.

Software agreements are discussed between the relevant NCB representatives and in the CSG. This discussion focuses on the available resources from any given country and the needs of ATLAS. After discussion between these two groups, a proposal for the Institutional Commitments for Computing deliverables is made to the Collaboration Board, which approves the Software Agreements. The Software Agreements are then reviewed by the RRB and are approved by the Research Director of CERN and codified as Memoranda of Understanding for Computing.

2.4 Membership of the U.S.ATLAS Collaboration

The U.S. ATLAS Collaboration consists of physicists and engineers from all U.S. institutions collaborating on the ATLAS experiment at the CERN LHC. Table 3-1 shows a list of the participating institutions. Individuals from these institutions share responsibility for the construction and execution of the experiment with collaborators from the international high-energy physics community outside the U.S.

Table 2-1: U.S. ATLAS Participating Institutions

(Agency support shown in parentheses)

Argonne National Laboratory (DOE)
University of Arizona (DOE)
Boston University (DOE)
Brandeis University (DOE/NSF)
Brookhaven National Laboratory (DOE)
University of California, Berkeley/Lawrence Berkeley National Laboratory (DOE)
University of California, Irvine (DOE/NSF)
University of California, Santa Cruz (DOE/NSF)
University of Chicago (NSF)
Columbia University (Nevis Laboratory) (NSF)
Duke University (DOE)
Hampton University (NSF)
Harvard University (DOE/NSF)
University of Illinois, Urbana-Champaign (DOE)
Indiana University (DOE)
Iowa State University (DOE)
Massachusetts Institute of Technology (DOE)
University of Michigan (DOE)
Michigan State University (NSF)
University of New Mexico (DOE)
State University of New York at Albany (DOE)
State University of New York at Stony Brook (DOE/NSF)
Northern Illinois University (NSF)
Ohio State University (DOE)
University of Oklahoma/Langston University (DOE)
University of Pennsylvania (DOE)
University of Pittsburgh (DOE/NSF)
University of Rochester (DOE/NSF)
Southern Methodist University (DOE)
University of Texas at Arlington (DOE/NSF)
Tufts University (DOE)
University of Washington (NSF)
University of Wisconsin, Madison (DOE)

2.5 U.S. ATLAS Project Management Structure

To facilitate interactions with the U.S. funding agencies and for effective management of U.S. ATLAS activities and resources, a project management structure has been established with the Project Office located at BNL. Appendix 2 shows the organization chart for U.S. ATLAS. This organization is headed by a U.S. ATLAS Project Manager supported by a Project Office along with U.S. Subsystem Managers for each of the major detector elements in which the U.S. is involved. The organization also includes an Institutional Board with representation from each collaborating institution, and an Executive Committee. The responsibilities of each will be described below. The U.S. ATLAS planning and management is being done in close cooperation with the overall ATLAS management. The U.S. Subsystem Managers interact closely with the corresponding overall ATLAS Subsystem Project Leaders, and the U.S. ATLAS Project Manager maintains close contact with the ATLAS Spokesperson, and the Technical and Resource Coordinators.

2.5.1 U.S. ATLAS Project Manager

U.S. ATLAS Project Manager (PM) has the responsibility of providing programmatic coordination and management for the U.S. ATLAS Construction Project and the Research Program addressed here. He/she represents the U.S. ATLAS Project in interactions with overall ATLAS management, CERN, DOE, NSF, the universities and national laboratories involved and BNL, the Host Laboratory. The PM is appointed by the Director of BNL and with concurrence of the DOE and NSF upon recommendation from the U.S. ATLAS Collaboration. The PM will serve as long as there is the continuing confidence of the Collaboration and the funding agencies. He/she reports to the BNL Director (or his/her appointed representative). The PM is advised in this role by an Executive Committee, which includes all U.S. Subsystem Managers, as described below. The PM may select a Deputy to assist him. With respect to technical, budgetary, and managerial issues, the U.S. Subsystem Managers, augmented by the Institutional Board Convener, act as a subcommittee of the Executive Committee to provide advice to the PM on a regular basis. Consultation with this subcommittee is part of the process by which the PM makes important technical and managerial decisions. An example of such a managerial decision would be a modification of institutional responsibilities.

1. Appointing, after consultation with the Collaboration, of U.S. Subsystem Managers (SMs) responsible for coordination and management within each detector subsystem. The SMs will serve with the PM’s continuing concurrence.
2. Preparing the yearly funding requests to DOE and NSF for the anticipated U.S. ATLAS activities.
3. Recommending to DOE and NSF the institution-by-institution funding allocations to support the U.S. ATLAS efforts. These recommendations will be made with the advice of the SMs, and the U.S ATLAS Executive Committee.
4. Approving budgets and allocating funds in consultation with the SMs and managing contingency budgets in accord with the Change Control Process in Section 4.5.
5. Establishing, with the support of BNL management, a U.S. ATLAS Project Office with appropriate support services.
6. Working with BNL management to set up and respond to whatever advisory or other mechanisms BNL management feels necessary to carry out its oversight responsibility.
7. Keeping the BNL Director or his chosen representative well informed on the progress of the U.S. ATLAS effort, and reporting promptly any problems whose solutions may benefit from the joint efforts of the PM and BNL management.
8. Interacting with CERN on issues affecting resource allocation and availability, preparation of the international MOUs defining U.S. deliverables and concurring in these MOUs.
9. Advising the DOE and NSF representatives at the ATLAS Resource Review Board meetings.
10. Negotiating and signing the U.S. Institutional MOUs representing agreements between the U.S. ATLAS Project Office and the U.S. ATLAS collaborating institutions specifying the deliverables to be provided and the resources available on an institution-by-institution basis.
11. Periodically reporting on project status and issues to the Joint Oversight Group.
12. Conducting, at least twice a year, meetings with the U.S. ATLAS Executive Committee to discuss budget planning, milestones, and other U.S. ATLAS management issues.

13. Making periodic reports to the U.S. ATLAS Institutional Board to ensure that the Collaboration is fully informed about important issues.

The channels for funding, reporting, and transmission of both types of MOUs are shown in Construction PMP. DOE funding will be a mixture of grants and Research Contracts through BNL. NSF funding will be through subcontracts through Columbia University. Further details on the identities and roles of the various participants in the U.S. ATLAS Collaboration governance are given below.

2.5.2 Institutional Board

The U.S. ATLAS Collaboration has an Institutional Board (IB) with one member from each collaborating institution and a Convener elected by the Board. The Convener serves for a two-year renewable term. The IB will normally meet several times per year. Under normal circumstances the meetings are open to the Collaboration, although closed meetings may be called by the Convener to discuss detailed or difficult issues. All voting is by IB members only, except in the case of the absence of a member when the missing member may appoint an alternate.

The IB members represent the interests of their institutions and serve as points of contact between the U.S. ATLAS management structure and the collaborators from their institutions. They are selected by the ATLAS participants from their institutions.

The Institutional Board deals with general policy issues affecting the U.S. ATLAS Collaboration. As chairman of this board the Convener will organize meetings on issues of general interest that arise and will speak for U.S. ATLAS on issues that affect the Collaboration. The Convener also will recommend for ratification to the Institutional Board the ad hoc committees charged with running the elections for the Convener and for the membership of the Executive Committee, as described in the next section. The Convener will recommend to the Institutional Board the establishment of any standing committees to deal with collaboration wide issues if the need arises. The Institutional Board also provides its recommendation on the appointment of the Project Manager to the BNL Director, and DOE and the NSF.

2.5.3 Executive Committee

The Executive Committee advises the Project Manager on global and policy issues affecting the U.S. ATLAS Collaboration or the U.S. ATLAS Construction and the Physics and Computing Projects. It also deals with issues external to the U.S. ATLAS Construction Project such as education, computing, physics analysis etc. The Executive Committee has meetings at least twice per year. Its membership is the following:

- The Deputy Project Manager,
- Associate Project Manager for Physics and Computing,
- Subsystem Managers, including each level 2 manager from the Physics and Computing Project (PCP)
- The Subsystem Representatives from each subsystem in which U.S. groups are playing a major role, their number being given in parentheses:
    - Semiconductor tracker (1),
    - TRT (1),
    - Liquid argon calorimeter and forward calorimeter (2),
    - Tile calorimeter (1),
    - Muon spectrometer (2),
    - Trigger/DAQ subsystems (1),
- The Education Coordinator,
- The U.S. members of the overall ATLAS Executive Board,
- The Convener of the Institutional Board.

The Subsystem Representatives are elected for two-year renewable terms by the IB members whose institutions are associated with the given subsystem.

The Education Coordinator, also elected for a two-year renewable term by the IB, is expected to actively promote educational programs associated with ATLAS and with the U.S. member institutions, and to report to the Executive Committee on these issues. He/she will also act as liaison to DOE and NSF for educational activities. The intended audiences for these education activities are a) the general public, b) secondary school students, c) undergraduates, and d) primary and secondary school teachers.

2.5.4 Associate Project Manager for Physics and Computing

The Associate Project Manager for Physics and Computing (APM) is responsible for the technical, schedule and cost aspects of the U.S. ATLAS Physics and Computing Project. (The scope of the U.S. ATLAS Physics and Computing Project is part of the U.S. preparations for participation in the ATLAS research program and is not part of the U.S. ATLAS Construction Project.) This Physics and Computing Project will follow all the features of this Project Management Plan in terms of defining a WBS for the deliverables, a detailed cost estimate and resource loaded schedule, controls and reporting. The APM develops the budgets for the institutions participating. The U.S. ATLAS Project Manager appoints the APM with concurrence from the Executive Committee. The APM appoints Software, Facilities and Physics Subsystem Managers with the concurrence of the Executive Committee.

2.5.5 Subsystem Managers

The Subsystem Managers are responsible for the technical, schedule, and cost aspects of their subsystems. They develop the budgets for the institutions participating in their subsystems. They are appointed by the U.S. ATLAS Project Manager upon recommendation of the IB members whose institutions are involved in that subsystem. The Subsystem Managers, augmented by the Institutional Board Convener, also act as a subcommittee of the Executive Committee advising the PM on technical, budgetary, and managerial issues relevant to the U.S. ATLAS Project. Prior to making important technical and managerial decisions, the PM will consult with this subcommittee.

2.5.6 Brookhaven National Laboratory (BNL) and Columbia University

The DOE and NSF have assigned BNL management oversight responsibility for the U.S. ATLAS Construction Project, as well as the U.S. ATLAS Research Program. The BNL Director has the responsibility to assure that the detector effort is being soundly managed, that technical progress is proceeding in a timely way, that technical or financial problems, if any, are being identified and properly addressed, and that an adequate management organization is in place and functioning. The BNL Director has delegated certain responsibilities and authorities to the Associate Laboratory Director for High Energy and Nuclear Physics. The Associate Director is responsible for day-to-day management oversight of the Construction Projects and the U.S. ATLAS Project Manager reports to him. Specific responsibilities of the BNL Directorate include:

1. Establish an advisory structure external to the U.S. ATLAS project for the purpose of monitoring both management and technical progress for all U.S. ATLAS activities;
2. Assure that the Project Manager has adequate staff and support, and that U.S. ATLAS management systems are matched to the needs of the project;
3. Consult regularly with the Project Manager to assure timely resolution of management challenges;
4. Concur with the International Memorandum of Understanding specifying U.S. deliverables for the U.S. ATLAS project funded by DOE and NSF.
5. Concur with the institutional Memoranda of Understanding for the U.S. ATLAS collaborating institutions that specify the deliverables to be provided and the resources available for each institution;
6. Ensure that accurate and complete project reporting to the DOE and NSF is provided in a timely manner.

The NSF Division of Physics has delegated financial accountability to Columbia University inclusive of line management authority, responsibility and accountability for overall project implementation, and contract administration. The Director of Nevis Laboratory is responsible for dispersal of NSF funds according to the allocations recommended by the U.S. ATLAS Project Manager and consistent with NSF Major Research Equipment (MRE) policies.

2.5.7 Project Advisory Panel

The Project Advisory Panel (PAP) is appointed by the Brookhaven Associate Laboratory Director, High Energy & Nuclear Physics. The role of the PAP in the U.S. ATLAS Detector Project is to provide oversight of the work performed in the Project plus advice to Laboratory management on the rate of progress in and adherence to the project plan as it relates to cost, schedule and technical performance. The primary mechanism for performing this oversight role is attendance at the Project Manager's periodic technical reviews of the U.S. ATLAS subsystems, followed by discussions among the attending PAP members with Project principals and Subsystem Managers. If necessary, additional other mechanisms may be employed as deemed necessary to exercise the oversight function. These may include special reviews or meetings and attendance at Department of Energy/National Science Foundation (DOE/NSF) reviews of the U.S. ATLAS Project. The PAP reports to Laboratory management by means of oral discussions plus a written report following each significant PAP review. PAP reports are transmitted to DOE and NSF.

2.5.8 Physics and Computing Advisory Panel

The Physics and Computing Advisory Panel (PCAP) is appointed by U.S. ATLAS Project Manager. The role of the PCAP in the U.S. ATLAS Detector Project will be to provide advice to the PM creation of, and on the rate of progress in and adherence to this Physics and Computing Project plan as it relates to cost, schedule and technical performance.

2.6 Department of Energy (DOE) and National Science Foundation (NSF)

The Department of Energy (DOE) and the National Science Foundation (NSF) are the funding agencies for the U.S. ATLAS Construction Project. As such they monitor technical, schedule, and cost progress for the program. The organizational structure is shown in Appendix 3.

The DOE has delegated responsibility for the U.S. ATLAS activities to the Office of Science, Division of High Energy Physics. The NSF has delegated responsibility for the U.S. ATLAS project to the Division of Physics, Elementary Particle Physics Programs.

The U.S. ATLAS Project receives substantial support from both DOE and NSF. Almost all the subsystems involve close collaboration between DOE and NSF supported groups. It is therefore essential that DOE and NSF oversight be closely coordinated. The DOE and NSF have agreed to establish a Joint Oversight Group (JOG) as the highest level of joint U.S. LHC Program management oversight. The JOG has responsibility to see that the U.S. LHC Program is effectively managed and executed so as to meet the commitments made to CERN under the International Agreement and its Protocols. The JOG provides programmatic guidance and direction for the U.S. LHC Construction Project and the U.S. LHC Research Program and coordinates DOE and NSF policy and procedures with respect to both. The JOG approves and oversees implementation of the U.S. LHC Project Execution Plan (PEP) and individual Project Management Plans which are incorporated into the PEP including the U.S. ATLAS Construction Project Management Plan.

All documents approved by JOG are subject to the rules and practices of each agency and the signed Agreements and Protocols.

The U.S. LHC Program Office and U.S. LHC Project Office are established to carry out the management functions described in the PEP. As the DOE has been designated lead agency for the U.S. LHC Program, the U.S. LHC Program Manager and the U.S. LHC Project Manager, who respectively head the program and project offices, will generally be DOE employees. The Associate U.S. LHC Program Manager will generally be an NSF employee.

2.6.1 U.S. LHC Program Office

The U.S. LHC Program Office has the overall responsibility for day-to-day program management of the U.S. LHC Program as described in the PEP. In this capacity, it reports directly to the JOG and acts as its executive arm. The office is jointly responsible with the U.S. LHC Project Office for preparation and maintenance of the PEP, and interfaces with the DOE Division of High Energy Physics and the NSF Division of Physics, which are the respective agency offices charged with responsibility to oversee the U.S. LHC Program. The Program Manager and Associate Program Manager are responsible for coordination between the agencies of the joint oversight activities described in the Memorandum of Understanding between DOE and NSF and in the PEP.

2.6.2 U.S. LHC Project Office

The U.S. LHC Project Office is responsible for day-to-day oversight of the U.S. LHC Projects as described in the PEP. In this capacity, the U.S. LHC Project Manager reports to the U.S. LHC Program Manager, and routinely interfaces with the Project Managers for each of the U.S. LHC Projects. These managers represent the contractors and grantees to DOE and NSF. These contractors and grantees have direct responsibility to design, fabricate, and provide to CERN the goods and services agreed in the International Agreement and Protocols.

3 Physics and Computing Project

There are two primary goals of the U.S. ATLAS Physics and Computing Project. The first is to provide the software, computing and support resources to enable collaborating U.S. physicists to fully participate in, and make significant contributions to the physics program of ATLAS. The second primary goal is to contribute to the overall ATLAS Computing effort in a degree which is both commensurate with the proportionate scale of the U.S. contributions to the detector construction and well matched to the expertise of the U.S. physicists specializing in computing.

The computing effort for the ATLAS experiment far exceeds that of previous high energy physics experiments in the scale of data volume, CPU requirements, data distribution across a global network, complexity of the software environment, and a widespread geographic distribution of developers and users of software.

There are three components of the Physics and Computing Project.

- Facilities: Hardware, networking and software support of U.S. Collaborators in data analysis and in computing contributions to the ATLAS Collaboration.

- Physics: Support of event generators, physics simulation, specification of physics aspects of facilities support.

- Software: Development and maintenance of software deliverables to the International ATLAS project, as specified in software agreements and memoranda of understanding between either CERN, the International ATLAS Collaboration and the U.S. ATLAS Physics and Computing Project.

The Physics and Computing Project covers the period from 1999 through the duration of the experiment. For expediency, the Project is delineated into two phases: the initial phase of the development of software, and support facilities prior to data taking, expected to be 2005, and the maintenance phase, where the Project must stay current with changes in computing technology, and provide ongoing support and development functions.

3.1 Physics and Computing Subproject Management

The project organization is presented in Appendix 4. The structure of the project organization reflects the three main components of the Physics and Computing Project: physics, facilities and software deliverables. These three components have level 2 WBS specifications and corresponding level 2 managers. The management structure is designed to reflect a natural flow of deliverables between U.S. ATLAS and International ATLAS, specifications and responsibilities for deliverables.

- Facilities: specifications of platform needs of U.S. ATLAS are negotiated with International ATLAS in the formulation of policies. Data and software releases are delivered from International ATLAS to U.S. ATLAS, where local support functions are provided for both.
- Software: Software deliverables are agreed to by International ATLAS and U.S. ATLAS.

3.1.1 Physics

The goal of the physics subproject is to provide support functions for physics related tasks both for the U.S. ATLAS Collaboration and specific responsibilities as negotiated with International ATLAS, such as support of certain event generators. The physics subproject deals with the development and maintenance of certain classes of physics objects (e.g. jets, missing energy). The physics subproject role also involves the establishment of crucial benchmark studies to measure the performance of software and facilities systems, in particular the coordination of mock data challenges for U.S. Facilities. There will be a substantial independence of all collaborators, U.S. and Internationally, in the area of data analysis, with the principle of democratic access to the data. This aspect is explicitly not included in the Physics Subproject.

3.1.2 Software

The goal of the software subproject is to provide a set of deliverable software packages to U.S. ATLAS, the International ATLAS Collaboration and CERN, as negotiated with these organizations and specified in the form of software agreements and Memoranda of Understanding. Within the project, software is divided into the following categories:

- Core: General purpose software that is not specific to a given detector subsystem
- Detector specific simulation and reconstruction
- Training
- Collaborative tools

Note that traditionally, detector specific simulation and reconstruction activities have been carried out by physicists and in the past have not involved the use of Project funds for their support. With modern software methodology, and with the increased complexity associated with the scale of the project, it is necessary to have a more systematic approach to this, including the use of some software professionals to support the activities of physicists and assist in the maintenance of reconstruction and simulation packages. Much of the specifications of reconstruction algorithms are based on decisions made by the International ATLAS Collaboration, and duties associated with the project include the implementation, documentation and maintenance of the associated software packages.

Requirements on the software are developed by the International ATLAS Collaboration, and deliverables are negotiated with the International Collaboration as part of software memoranda of understanding.

3.2 Facilities Subproject

The goals of the facilities subproject is to provide the basis for the support of U.S. ATLAS physicists in the analysis of data from the ATLAS experiment, and to carry out specific computing tasks for the International ATLAS experiment as per agreement between the two. The facilities subproject consists of the following major pieces:

1. Regional (Tier 1) computing center at Brookhaven National Laboratory.
2. Software support of a code repository at BNL and support of U.S. Physicists in the use of ATLAS software.
3. Tier 2 centers. There will be roughly 5 tier 2 centers for U.S. ATLAS. These are to be linked together and with the Tier 1 center to form a coherent computing grid environment. Software hardware support functions are also carried out at these locations.
4. Participation in the construction of grid software.
5. Modeling tasks to optimize resource usage.

3.3 Upper level project management: description of responsibilities

Associate Project Manager

1. Develop a project plan, conforming to the technical and scientific needs and policies of ATLAS and U.S. ATLAS.
2. Execute the approved project plan.
3. Establish and maintain the project organization and tracking, with the resources of BNL. This includes the management of procurements, schedules, reporting, etc.
4. Develop the annual budget request to the DOE and NSF. The requests are reviewed by the level 2 project managers and are approved by the Project Manager.
5. Act as a liaison between the project and the ATLAS Computing management.
6. Appoint the L2 managers, with the advice and concurrence of the EC and Project Manager.
7. Provide coordination and oversight to the subprojects, by requiring appropriate reporting and tracking, and the results of technical review.
8. Review and approve memoranda of understanding (MOU) between CERN and the Project, and between the Project and U.S. ATLAS Collaborating institutions.
9. Allocate money and resources within the project.
10. Exercise change control authority.
11. Establish advisory committees where appropriate.
12. Provide reports and organize reviews in conjunction with the funding agencies.

Project Engineer

1. Provide technical input to the development of the baseline project plan, especially with respect to budget and personnel requirements, deliverables, milestones and contingency.
2. Develop an integrated cost and schedule plan.
3. Reporting variances from the scope, schedule or cost estimates to the APM.

Level 2 Managers: Generic Responsibilities

The level 2 managers share a common set of responsibilities in their relation to the project. These are to:

1. Develop, in collaboration with the APM the definition of the milestones and deliverables of the subproject.
2. Develop, subject to review by the APM, the technical specifications of each component and deliverable of the sub-project.
3. Define, in consultation with the APM the organizational substructure of the subproject.
4. Develop, with the guidance of the APM, the annual budget proposal for the subproject.
5. Identify resource imbalances within their subprojects and recommend adjustments within the limits of the allocated resources.
6. Deliver the scope of the subproject on schedule, within budget and in conformance with the technical specifications of the project.
7. Be accountable for all funds allocated to the subproject.
8. Maintain the cost and schedule plan for the subproject.
9. Provide reports as required to the APM, PM.

Physics Subproject Manager

1. Provide support for physics generators, as per agreement with International ATLAS
2. Support for physics objects
3. Creation of benchmark studies to assess software and facilities readiness
4. Management of the user side of the mock data challenges
5. Provide requirements for the U.S. ATLAS computing facilities and relevant software packages

Software Subproject Manager

1. Provide oversight to agreed simulation/reconstruction activities undertaken by U.S. ATLAS groups.
2. Provide oversight and input to the U.S. ATLAS Training Coordinator in relevant software technologies.
3. Appoint level 3 and 4 managers in the software subproject, with the advice and concurrence of the APM.
4. Assist the APM in the development of software MOU's between the Physics and Computing Project and CERN
5. Assist the APM in the development of software MOU's between the U.S. ATLAS Project and participating institutions. Assess the resource requirements of proposed U.S. ATLAS software deliverables to ensure a proper matching between resources and deliverables.
6. Assess the needs of U.S. Physicists for support of ATLAS software packages, develop and implement a support plan.
7. Assess the technical risks of implementation strategies being proposed by participating U.S. Institutions and advise the APM and International ATLAS any unacceptable risks
8. Oversee core software deliverables from the U.S.

Facilities Subproject Manager

1. Assess the resource requirements of proposed U.S. ATLAS facilities and develop a plan to meet these requirements at the regional center.
2. Implement the plan for the U.S. ATLAS computing facilities.
3. Represent the U.S. ATLAS Physics and Computing Project on matters related to computing at regional centers.
4. Develop a plan to address the U.S. contributions to the computational needs of the ATLAS experiment, including data analysis and simulation.
5. Appoint level 3 and 4 managers in the Facilities subproject, with the advice and concurrence of the APM.
6. Assist the APM in the development of facilities MOU's between the Physics and Computing Project and CERN.
7. Assist the APM in the development of facilities MOU's between the U.S. ATLAS Project and participating institutions.

3.3.7 Computing Coordination Board

The Computing Coordination Board is jointly chaired by the Physics Manager and the IB Chair. Sitting on the board are the Associate Project Manager for Physics and Computing, the Software and Facilities Managers and three other representatives from the U.S. ATLAS Collaboration. The three at-large representatives are selected by the Institute Board. The purpose of the Computing Coordination Board is to aid in the allocation of existing resources and assess the needs of the collaboration, and provide advice to the Associate Project Manager on these issues. The Computing Coordination Board represents the means for direct input from the U.S. ATLAS Collaboration into the Physics and Computing Project. The co-chairs are delegated to poll the Collaboration on any Physics and Computing issues as they see fit, and to organize Physics and Computing sessions as they see fit. The Computing Coordination Board also oversees the selection of sites for Tier 2 centers.

3.4 Software Agreements

A software agreement is established between the International ATLAS Collaboration and the U.S. ATLAS Computing and Physics Project, specifying the nature of the deliverables and/or level of effort associated the deliverables and their maintenance. Out of the overall software agreement established between International ATLAS and the U.S. ATLAS Computing and Physics Project, relevant software agreements are established between the U.S. ATLAS Computing and Physics Project and participating U.S. ATLAS Institutions. The principal software agreement is signed by the APM, appropriate representatives of the funding agencies and the Spokespersons of the ATLAS Experiment. The software agreements between the U.S. ATLAS Computing and Physics Project are signed by the APM and the relevant representatives of the participating institutions.

3.5 Memoranda of Understanding

An MOU's is established between the International ATLAS Collaboration and the U.S. ATLAS Computing and Physics Project, specifying the nature of the deliverables and/or level of effort associated the deliverables and their maintenance. Out of the overall MOU established between International ATLAS and the U.S. ATLAS Computing and Physics Project, relevant software agreements are established between the U.S. ATLAS Computing and Physics Project and participating U.S. ATLAS Institutions.

3.6 Computing and Physics Policies

A number of policy issues must be spelled out. These include local platform support, and the use of physicists within the project.

3.6.1 Local Computing Hardware Support

Until the establishment of Tier 2 centers, most of the CPU and I/O intensive computing jobs are to be performed at the Tier 1 regional center. It is recognized that there is a need for modest platform support locally at institutions for the purposes of development. Modest support will be provided for software development at institutions that have taken on a significant responsibility, providing a working arrangement can be made such that there is an coordination in the purchase of U.S. supported platforms, and the understanding that the majority of the computation is to be carried out at the Tier 1 center. As Tier 2 centers are established, there will be a net migration of some effort to these areas.

3.6.2 Physicist Support

It is recognized that there will be a substantial amount of physicist support required. This is estimated to be at the level of roughly 50 post-doctoral scientists at the start of active data taking. As a matter of policy, it is noted that physicists are not to be included in the project funding, yet this is a substantial amount of manpower which much exist in order for the U.S. ATLAS Physics and Computing Goals to be met. These physicists must come from the base program. Ideally a large fraction of this may be incremental or may be the result of redirection of effort.

We note that there is an additional category of support staff, which is considered to be on project. This is in the category of applications physicist. An applications physicist is typically a computer professional who has a strong background in physics and computing, and is not on an academic track. In the areas of detector specific simulation and reconstruction, we expect that there will be roughly two applications physicists per subsystem contributing to the development and maintenance of software deliverables.

3.6.3 Relation to the Construction Project

A number of areas have potential overlap with the construction project. Broadly speaking, any software or computing that is directly in support of, and derives from the construction project falls in the domain of the construction project. In areas of commonality, however, there can be a cost sharing between the two projects, as agreed upon by the PM and APM. Examples of this would be computing support for simulations that directly impact detector design issues, or software that is common to both online and offline reconstruction. It is the ultimate responsibility of the PM, in consultation with the APM to decide on where boundaries exist between the two projects and how cost sharing is to be carried out.

3.7 Cost Estimates for Physics and Computing

In Appendix 1, we list a preliminary cost profile for the Physics and Computing Project, from 1999 through 2006. The asymptote of level funding may not occur until the year 2008, however. Nonetheless the funding for FY '06 can be taken as indicative as the typical level of steady state funding. A breakdown of the costs may be found in the Software and Facilities Workplans. We have assumed the following yearly costs per FTE associated with subsystems as: $200k/year in core software professionals, $150k/year in other software professionals, $140k/year in facilities support personnel.

3.7.1 Core Software

Core software estimates were derived from comparisons with the effort required at existing experiments (BaBar, CDF and D0). The data management effort includes roughly one half of the overall effort to be devoted to data management systems, where it is expected that other collaborators would take up the additional effort. The control/framework effort is self-contained as a U.S. responsibility. Note that some sharing with other experiments may reduce the overall cost burden.

The details of the anticipated software deliverables to ATLAS are described in the U.S. ATLAS Software Development Work Plan. In the table below, we detail the cost estimates for the core software effort through the year FY 06. Note that in the years FY 01 and beyond, we have used a contingency of 40%. Although this number is rough at the moment, it is not incommensurate with the contingencies for similar efforts, and will be refined as the Physics and Computing Project develops more refined estimates.

Table 3-1: Cost Estimates for the core software efforts (FY00$)

	FTE	FY 99 $K		FY 00		FY 01		FY 02		FY 03		FY 04		FY 05		FY 06	Total	Total $k
Core																		
Control	0.6	120	3.1	620	5.3	1060	5.3	1060	4	800	3	600	2	400	2	400	25.3	5060
Data management	0.7	140	3	600	5	1000	6	1200	7	1400	7	1400	7	1400	7	1400	42.7	8540
Subtotal	1.3	260	6.1	1220	10.3	2060	11.3	2260	11	2200	10	2000	9	1800	9	1800	68	13600
Contingency	1		1		1.4		1.4		1.4		1.4		1.4		1.4			
Subtotal w/ cont.		260		1220		2884		3164		3080		2800		2520		2520		18448

3.7.2 Detector Specific Simulation and Reconstruction Software

Here it is expected that the majority of the effort comes from physicists supported on the base program. It is noted that some level of support in the area of software integration, particularly in the areas of distributed computing environments, and code management will require some effort from software professionals. We have included an asymptote of two software professionals per subsystem, with the activity profile indicated in the spreadsheet. It should be noted that one expects an effort of roughly 50 postdoctoral scientists in this area, who are to be funded on the base program, and hence do not appear on project. We assume a roughly linear ramp from the present to the asymptote in 2006 of 50 postdoctoral scientists.

The following table gives an outline of the estimated Project manpower required to support the simulation and reconstruction activities. Note that this only specifies computing professionals to support each subsystem and does not specify the physicist activity on the base program. The computing professionals are expected to support the activities centered in geographical sites associated with the simulation and reconstruction work on specific subsystems. Note that we are specifying an asymptotic level of two computing professionals per detector subsystem, with no contingency. This is specified as a level-of-effort. The details of the simulation and reconstruction activities and plans are described in detail in the U.S. ATLAS Software Development Workplan.

Table 3-2: Simulation and Reconstruction Activities Supported on Project Funds (FY00$)

Sim/recon	FTE	Fy 99$K		FY 00		FY 01		FY02		FY 03		FY 04		FY 05		FY 06	Sum	Sum
Inner Detector			0	0	0	0	1	150	2	300	2	300	2	300	2	300	9	1350
TRT			0	0	1	150	1	150	2	300	2	300	2	300	2	300	10	1500
E-Cal	0.5	75	1	150	1	150	2	300	2	300	2	300	2	300	2	300	12.5	1875
Tilecal			1	150	1	150	2	300	2	300	2	300	2	300	2	300	12	1800
Muons			0	0	1	150	2	300	2	300	2	300	2	300	2	300	11	1650
Trigger/DAQ			0	0	0	0	1	150	2	300	2	300	2	300	2	300	9	1350
Subtotal		75	2	300	4	600	9	1350	12	1800	12	1800	12	1800	12	1800	63	9525
Contingency	1		1		1		1		1		1		1		1			
Subtotal w/ cont.		75		300		600		1350		1800		1800		1800		1800		9525

3.7.3. Physics Support

It is anticipated that there will be effort in the area of the Physics Subproject that will require a software professional whose job it is to provide updates to event generators and interfaces to ATLAS software, and maintain documentation for usage in the ATLAS environment. In addition to this, the establishment of software to monitor physics benchmark studies and preparations for mock data challenges will take a substantial amount of effort. We anticipate that a software professional will be essential to support this effort, which is part of the project aspects of computing. This is deemed as a level-of-effort of one FTE software professional, starting in FY 01.

Table 3-3: Physics Support Software Professional (FY00$)

Physics	FTE	FY 01 $k		FY 02		FY 03		FY 04		FY 05		FY 06		Sum
Event Generator	1	140	1	140	1	140	1	140	1	140	1	140	6	840
Contingency	1		1		1		1		1		1			
Subtotal w/ cont.		140		140		140		140		140		140		840

3.7.4 Training, Collaboratory Tools, Software Support

Training, Collaboratory Tools and Software Support all fall in the domain of the Software part of the Physics and Computing Project (WBS 2.2). Software support is deemed a "level of effort" of one computing professional who maintains ATLAS releases on the U.S. supported platforms and makes available code releases to U.S. users. Training and Collaboratory tools are the means by which the Collaboration is effectively trained in modern computing practices and communication is effected among the collaborators. Although the cost associated with both items are small, it represents a substantial leverage to the overall program.

	FTE	FY 99 $K		FY 00		FY 01		FY 02		FY 03		FY 04		FY 05		FY 06	Total	Total $k
~~Training/Support~~																		
Training/Tools		20		40		30		30		30		30		30		30		240
Support			1	150	1	150	1	150	1	150	1	150	1	150	1	150	7	1050
Contingency		1		1		1		1		1		1		1		1		
Subtotal w/ cont.		20		190		180		180		180		180		180		180		1290

3.7.5 Facilities

The U.S. ATLAS computing facilities are based on a hierarchical model of sites, starting with the CERN facilities as the primary (Tier 0) site. The assumption is that all of the raw data from ATLAS are stored at this Tier 0 site. The U.S. Regional Center, or Tier 1 site, located at Brookhaven National Laboratories, will cache a subset of this data and perform computing tasks as required both by the ATLAS Collaboration and U.S. ATLAS in support of U.S. responsibilities and analysis activities. Beyond the Tier 1 sites, are a set of five or six Tier 2 centers, each of which have a fraction of the capabilities of the Tier 1 sites, but in aggregate, the CPU will sum to a level beyond that of the Tier 1 site, whereas the manpower and hardware costs at the Tier 1 site exceed those of the sum of the Tier 2 sites. The various sites in the hierarchy are linked together by a computational grid, which allows transparent access to users and automatic scheduling of resources. The usage of the U.S. Facilities serves the role of supporting International ATLAS as per agreements on the computing responsibilities, and also the support of U.S. physicists doing analysis, simulation and calculations supporting their efforts. The details of the facilities planning are given in the U.S. ATLAS Facilities Workplan.

Requirements for the scale of computing facilities is coupled with the needs of the collaboration and has substantial input from the Physics Manager and the U.S. ATLAS Collaboration at large. The basic principle is to allow the widest possible access to data and CPU power to all users. A major component of this infrastructure includes high-bandwidth links between the Tier 1 and Tier 2 sites.

Another aspect of the Facilities subproject is user support, which includes a help desk at the Tier 1 site, and a local storage and release of ATLAS and supporting software. Since there is an ongoing need to perform simulations to optimize trigger performance, shielding, the detector configuration, etc, with many U.S. physicists participating in these exercises, it is essential that the Tier 1 facilities, already in existence at Brookhaven, be maintained and continually upgraded as milestones such as the mock data challenges are approached.

The cost estimates given below are based on the assumed scale of the computing required for Tier 1 and Tier 2 regional facilities. The details of the assumptions and scope of the facilities considered here are given in the U.S. ATLAS Computing Facilities Workplan. Note that in the table below, there is no contingency shown, although in our summaries, we have applied a uniform contingency of 40% from FY 01 on until FY 06.

Facilities	FTE	FY 99 $K		FY 00		FY 01		FY 02		FY 03		FY 04		FY 05		FY 06		Sum
Tier 1 Hardware		110	0	220	0	560	0	590	0	910	0	1650	0	2450	0	2130	0	8620
Tier 1 Staffing	1	100	4	560	8	1120	11	1540	16	2240	19	2660	25	3500	25	3500	109	15220
Tier 2 Staffing	0	0	0	0	1	140	3	420	8	1120	12	1680	12	1680	12	1680	48	6720
Tier 2 Hardware			0	0	0	190	0	380	0	1150	0	1380	0	2580	0	2110	0	7790
Tier 2 Subtotal			0	0	1	330	3	800	8	2270	12	3060	12	4260	12	3790	48	14510
Networking		0	0	0	0	160	0	260	0	710	0	790	0	1060	0	820	0	3800
Subtotal no cont.	1	210	4	780	9	2170	14	3190	24	6130	31	8160	37	11270	37	10240	157	42150

Table 3-4: Facilities Cost Profile (FY00$)

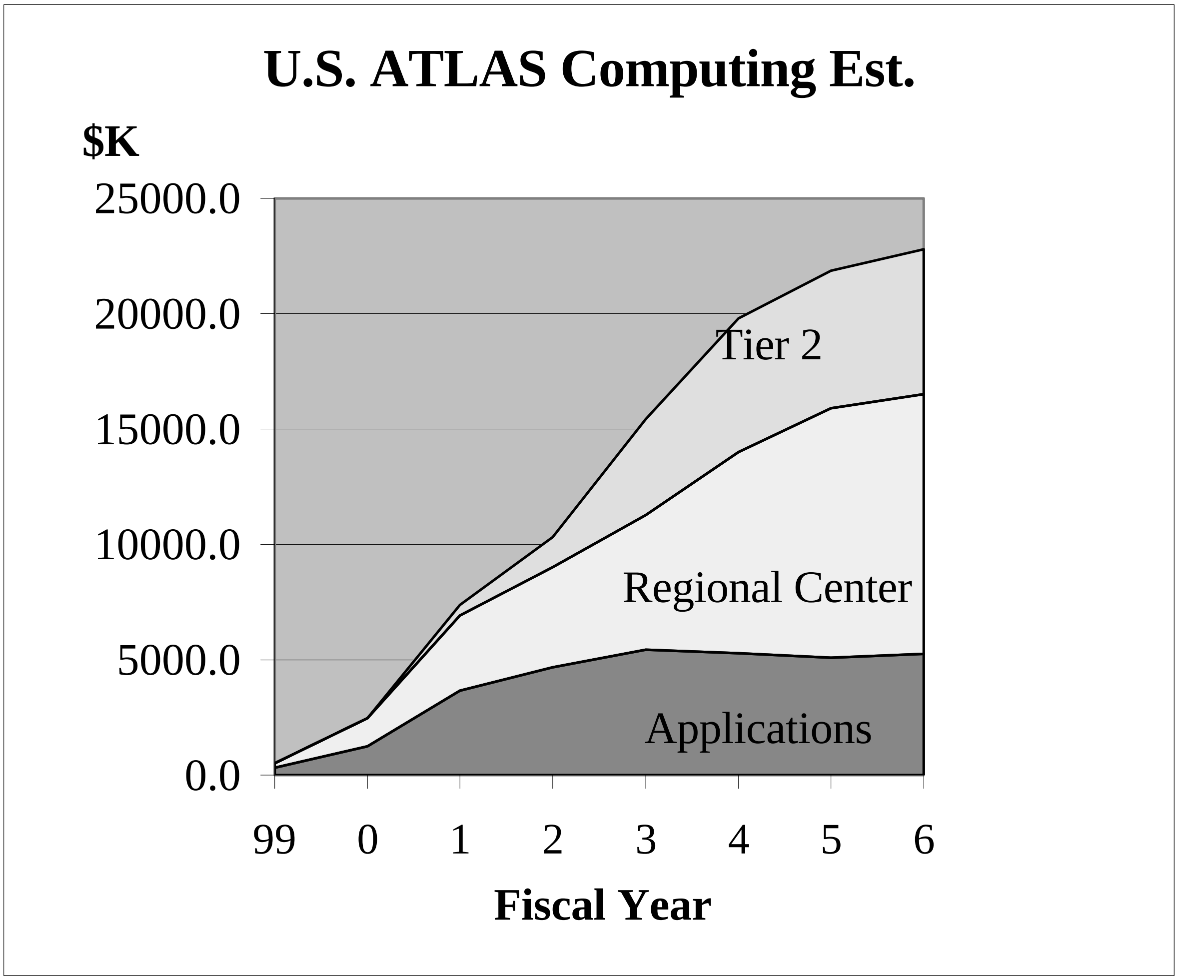
3.7.7 Cost Escalation and Contingency

All items are evaluated in FY 00 dollars. At the summary level of each item, after appropriate contingencies have been applied, we use a set of cost escalation figures, based on standard government guidance, to derive at-year cost estimates. These summaries are show in the table below.

Table 3-5: Cost summaries including escalation (FY00$)

	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	FY 06	Sum
FY Multipliers	0.98	1	1.025	1.0517	1.0811	1.114	1.1436	1.1779	
Application Sub	347.9	1710.0	3899.1	5083.9	5621.7	5480.9	5306.3	5465.5	32915.3
Tier 2 Facilities	0.0	0.0	473.6	1177.9	3435.7	4772.4	6820.4	6249.9	22977.9
Tier 1 Facilities	205.8	780.0	2640.4	3519.0	5842.3	7954.0	11223.3	10636.4	42801.1
Sum	553.7	2490.0	7013.1	9780.8	14899.7	18207.2	23350.0	22351.8	98694.4

This information is displayed graphically below as a function of fiscal year. Note that the distinction between the Regional Center and the associated costs for the Tier 2 centers are not completely inseparable as the cost of links has been absorbed into the cost of the Regional Center.



4 Management and Control System

The U.S. ATLAS project management control system (PMCS) incorporates three primary elements in the scope definition. These elements are the same as in the construction project, and will be followed to the extent possible in the physics and computing project.

- Baseline Development - Defining project scope and establishing the necessary cost and schedule baselines and work execution plans.
- Project Performance - Project status monitoring, reporting and performance analysis.
- Change Control - Management of project baselines and contingency funds.

4.1 Baseline Development

The cost and schedule baseline and the hierarchical relationships are defined in a Work Breakdown Structure. Detailed cost estimates have been developed using appropriate standard estimating methodologies, and integrated with the work scope definition. Schedules and plans are being developed using a disciplined approach that integrates the work scope with the cost estimate. Resources defined in the detailed estimate are applied to the tasks established in the schedule to generate a time-phased budget. These resource-loaded schedules are then aligned to the budget profile and this establishes the schedule and cost baseline. This baseline establishes the Budgeted Cost of Work Scheduled (BCWS) which is used to formulate the overall funding profile.

4.2 Project Performance

Project performance integrates the work authorization with the funds management and accounting processes to provide a performance analysis capability that is used for reporting to both management and the DOE/NSF. Funds management is based on funds authorized by both the DOE and NSF that are allocated to the individual institutions in accordance with the baseline estimate and the needs of the project. Funding is planned to occur twice each year. Work authorization is provided for each institution through the U.S. Institutional MOU process which defines the full work scope, including deliverables, and establishes the fiscal year funding. A yearly amendment to the Institutional MOU specifies the funding ceiling to each institution for each subsystem. Standard accounting processes are used to collect actual costs for completed work and to define the funds available for the remainder of the fiscal year. Performance analysis is provided through processing the schedules where comparisons are made between Budgeted Cost of Work Performed (BCWP) and (BCWS) as well as between BCWP and Actual Cost of Work Performed (ACWP). These comparisons provide a determination of project status, and help identify potential problems that cause schedule and cost variances.

The rudiments of performance analysis are embedded in the PCMS. The resource-loaded schedules generated during baseline development are statused on a quarterly basis and a comparison of BCWP and BCWS will yield a Schedule Variance (SV) that can be isolated to the specific task or tasks causing the variance. Also a comparison of BCWP and ACWP will yield a Cost Variance that can be attributed to the specific task or tasks causing the variance. This information can be used to establish work-arounds that will hopefully mitigate the problems.

A status report is issued each quarter that contains the following information:

1. U.S. ATLAS Project Managers overview and assessment of the project
2. A narrative describing the status of technical work, significant project accomplishments, problems and corrective action if applicable
3. A milestone schedule and status report at WBS level 2, identifying completed milestones, slippage and the percentage planned and completed based on cost performance data
4. Milestone Log
5. Critical path items will be identified for each WBS level 2 Subsystem
6. A Cost Schedule Status Report (CSSR) at WBS level 2 identifying BCWS, BCWP, ACWP, SV, CV, Budget at Completion (BAC), Estimate at Completion (EAC) and Variance at Completion

7. Variance analysis and corrective action plans where applicable

4.3 Reporting

4.3.1 Technical Progress

The responsible person in each institution responsible for effort on the PCP writes the progress by Level 3 WBS on a quarterly basis. Each item should refer to the appropriate Level 5 WBS element and any relevant milestones which are completed. This is due on a quarterly basis and is sent to the Subsystem Manager(s). Each Subsystem Manager(s) collates the input and sends it to the Project Manager by the 15th of the month after the end of each quarter. The APM for PCP reviews the reports and collates them into a single report, which is made available to the collaboration. Reports are to be logged centrally at a location associated with the U.S. ATLAS Project Office.

4.3.2 Costs

Each institution reports on each Level 5 item which is active in the following categories: The reports are placed on Atlas2 in: /pub/Incoming/Project_Management/Reporting/ Financial_Reporting. This is due on the 15th of the month following the end of the quarter in the Project Office. Reports are provided to the Subsystem Managers.

4.3.3 Performance

Each Subsystem Manager provides an estimate of the progress of each WBS Level 5 item by percentage by the 15th of the month after the end of the quarter. This is accomplished by updating EXCEL spreadsheets located on Atlas2 in /Project_Office/Reporting/Status. These reports of schedule and cost variance can be rolled up to any higher level.

There are schedule status and turn-around documents. These are standardized for schedules and performance measurements at Level 5 of the WBS.

Reporting processes are employed to provide timely, accurate periodic progress reports which enable analysis, evaluation, and corrective action of work scope, schedule, and cost performance against the approved baseline.

4.4 Procurements

The U.S. ATLAS Construction Project has defined procurements over $100k as major and subject to PO tracking and control. These will be listed in a future version. *****

U.S. ATLAS Project Manager approval is required before a bid is solicited for a major procurement. The U.S. ATLAS Project Manager approves the actual contract award.

4.5 Change Management

The Change Control Process outlined in Table 4-1 is used to control changes to the Technical, Cost and Schedule Baselines. The membership of the Change Control Board (CCB) consists of the following:

Chair –Associate Project Manager for Physics and Computing

- Project Manager
- Deputy Project Manager for Physics and Computing

Subsystem Managers

- Facilities Manager
- Software Manager

Physics Manager

Project Office

Computing Project Engineer

Project Planning Manager

Baseline Change Proposals (BCP) for changes to the detector Technical, Cost and Schedule baselines are referred to the CCB. The following changes are required to be submitted for consideration by the Physics and Computing CCB.

1. Any change that affects the interaction with ATLAS computing systems. Such changes also require the concurrence of the ATLAS Change Control Board.
2. Any change that impacts the performance, the cost or schedule baselines within established thresholds, of the U.S. deliverables.
3. Any change to the project contingency budget.

The CCB considers the change and its impact, consulting, when necessary, with appropriate outside technical experts. Thresholds for the approval of changes to the detector configuration, cost and schedule are summarized in Table 4-2 along with those responsible for each level of change. After the CCB recommends action on the BCP, the PM approves or rejects the BCP. The BNL Associate Laboratory Director is also required to approve all BCPs involving a cost or schedule change. Upon approval, the change is incorporated into the baseline. An audit trail is provided for each change.

Contingency funds are held by the U.S. ATLAS Project Manager. Contingency funds may be allocated in response to requests for funds required in excess of the base cost. Such requests are reviewed and approved in accordance with the change control procedures.

Table 4-1: U.S. ATLAS Change Control Process

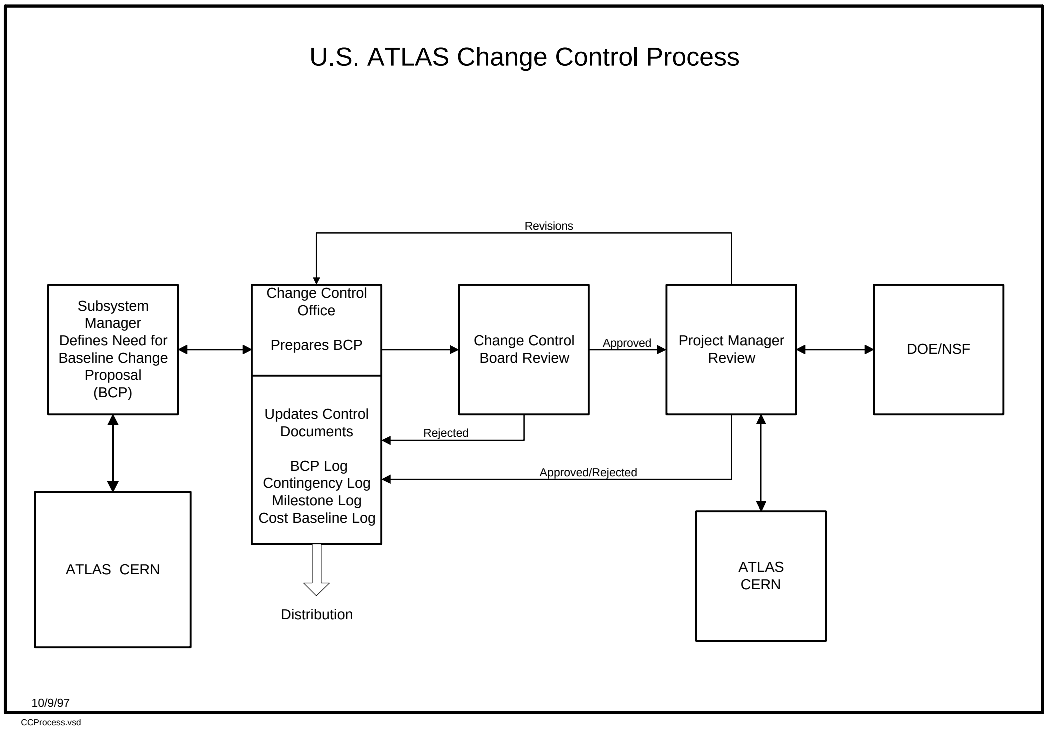


Table 4-2: U.S. ATLAS Change Control Thresholds

	Level 1 DOE/NSF Joint Oversight Group	Level 2 DOE/NSF Project Manager	Level 3 U.S. ATLAS Project Manager and BNL Associate Laboratory Director
Technical	Changes to the project purpose or goals.	Changes to the baseline list of deliverables	Changes that do not affect the Level 1 and Level 2 control items.
Cost	Changes to the Total Project Cost	Changes to the Level 2 Cost Baseline.	Changes to the cost baseline at WBS Level 3.
Schedule	Greater than 6-month change in a Level 1	Greater than 3-month change in a Level 2 milestone	Any change in a Level 3 milestone

4.6 Host Laboratory Oversight

As discussed earlier, the BNL Director has been charged by DOE and NSF with management oversight responsibility for the U.S. ATLAS activities, and he may delegate this responsibility to the BNL Associate Laboratory Director, High Energy and Nuclear Physics. The Associate Laboratory Director (ALD) has appointed a Project Advisory Panel (PAP) consisting of individuals outside of the U.S. ATLAS Collaboration with expertise in the technical areas relevant to the Project and the management of large projects, to assist him in carrying out his oversight responsibility. The PAP meets at least once per year, or more frequently if required, and its report to the ALD is also transmitted to the DOE/NSF Joint Oversight Group and to the U.S. ATLAS Project Manager. The ALD works with the PM to address any significant problems uncovered in a PAP review.

4.7 Meetings with DOE and NSF

There are regular coordination meetings between the DOE/NSF Project Manager, the Joint Oversight Group, the ALD, and U.S. ATLAS project management personnel for problem identification, discussion of issues, and development of solutions. Written reports on the status of the U.S. ATLAS Construction Project are submitted regularly, as specified in Table 4-3.

Table 4-3: Periodic Reports to DOE and NSF

REPORT	FREQUENCY	SOURCE	RECIPIENTS
Project Status	Quarterly	U.S. ATLAS Collaboration	DOE/NSF Program/Project Staff, BNL Associate Laboratory Director, PAP, Executive Committee, Institutional Representatives

4.8 Periodic Reviews

Peer reviews, both internal and external to the Collaboration, provide a critical perspective and important means of validating designs, plans, concepts, and progress. The Project Advisory Panel, appointed by the BNL Associate Laboratory Director provides a major mechanism for project review. The PAP will have computing expertise on it, and will receive the reports of the PCAP. The DOE and NSF will set up their own Technical, Management, Cost and Schedule Review Panels to review the research, development, fabrication, assembly and management of the project. In addition, the PM sets up internal review committees to provide technical assessments of various U.S. ATLAS activities, as he/she considers appropriate. Normally, all review reports are made available to members of the U.S. ATLAS Collaboration. However, if a particular report contains some material that, in the opinion of the authority to which the report is addressed, is too sensitive for general dissemination, that material may be deleted and replaced by a summary for the benefit of the Collaboration.

5 Review and Modification of this Project Management Plan

After its adoption, this Project Management Plan is periodically reviewed by the Project Manager, the Associate Project Manager, and the Subsystem Managers as part of the preparation for reviews by the PAP. Proposals for its modification may be initiated by the PM, the APM, the Executive Committee, the BNL Associate Laboratory Director, and the funding agencies. Significant changes to the plan require approval of the Joint Oversight Group. Modifications of the Project Management Plan will require approval of the PM, the Associate Laboratory Director, the DOE/NSF Project Manager, and the Joint Oversight Group.

6 Work Breakdown Structure (WBS)

2.1 Physics

Covers “project” aspects of physics. This includes evaluation and creation of benchmarks for the performance of software, preparation for mock data challenges, and the support of event generators and their ATLAS interfaces that the U.S. takes on as responsibilities.

2.1.1 Physics Benchmarks

Project based effort devoted to establishing physics benchmarks to track the performance of software releases.

2.1.2 Mock Data Challenges

Effort, including software, directed at the preparation for and evaluation of mock data challenges within the U.S. and any global ATLAS effort.

2.1.3 Event Generation

Support of event generators and interfaces to ATLAS software.

2.1.4 Physics object software

Software for the creation and manipulation of physics objects (e.g. jets, electrons, missing energy)

2.2 Software Projects

Software projects that are part of the overall ATLAS (also LHC) effort. This work includes contributions to projects that the U.S. takes on as part of an overall MOU with ATLAS for software deliverables. In distinction, there is software effort associated with the regional center effort, which is mainly targeted as support for U.S. users.

2.2.1 Core Software

Non detector specific software efforts in the U.S. as part of the general computing infrastructure.

2.2.1.1 Control/Framework Software

Steering code to provide overall framework for ATLAS software

2.2.1.2 Database Management Systems

Database systems, including interfaces to commercial products.

2.2.1.3 Event Model

Description of the event as seen from the viewpoint of the physicist and how it maps into the datastore.

2.2.1.4 User Analysis Tools

Includes event visualization, histogramming and fitting packages

2.2.1.5 General Simulation and Reconstruction Software

Covers general (i.e. not detector specific) aspects of simulation and reconstruction. Examples include general detector description.

2.2.2 Detector specific simulation and reconstruction

2.2.2.1 Inner Track simulation and reconstruction software

Software, including calibration, for simulation and reconstruction for the inner tracker subsystem.

2.2.2.2 Transition Radiation Tracker simulation and reconstruction software

Software, including calibration, for simulation and reconstruction for the TRT subsystem.

2.2.2.3 Liquid Argon Calorimeter simulation and reconstruction software
Software, including calibration, for simulation and reconstruction for the LAr subsystem.

2.2.2.4 Tilecal simulation and reconstruction software
Software, including calibration, for simulation and reconstruction for the Tilecal subsystem.

2.2.2.5 Muon simulation and reconstruction software
Software, including calibration, for simulation and reconstruction for the muon subsystem.

2.2.2.6 Trigger/DAQ software
Software supporting the trigger and DAQ system.

2.2.2.7 Background studies
Associated with shielding, etc.

2.2.3 Collaborative Tools
Tools that allow collaboration from remote sites, including video conferencing, virtual notebooks, etc.

2.2.4 Software Support
Installation, support, and help desk for US installations of ATLAS offline software. US ATLAS Software Librarian.

2.2.5 Training
Training of physicists and students in software methodology, documentation and ATLAS specific packages.

2.3 Facilities

2.3.1 Tier 1 Regional Center at BNL

2.3.1.1 Hardware

2.3.1.1.1 Development and Test systems
Development software platforms for core and detector specific simulation and reconstruction software. Testing of prototype systems for full scale regional center.

2.3.1.1.2 Simulation and reconstruction
Simulation and reconstruction hardware associated with CPU intensive tasks at the Regional center.

2.3.1.1.3 Data storage
Tape and disk hardware for storage of simulated and actual data.

2.3.1.1.4 Information servers
Web sites and e-mail servers.

2.3.1.1.5 Desktop systems
Desktop computing resources for local users and visitors to regional center.

2.3.1.1.6 Data Mining/Analysis

2.3.1.1.7 Local Area Network

2.3.1.1.8 Infrastructure support

2.3.1.2 Facilities Software

Support for third party and community software tools used by ATLAS, and facility-related software. Note that in many cases, the majority of the software tools are written elsewhere, but they must be supported for U.S. users, including necessary adaptations to U.S. platforms, needs, etc.

2.3.1.2.6 Database and database management

Software purchase, modifications and interfaces for the management of event, calibration and other data resident at Regional Center.

2.3.1.2.7 Data distribution software

This includes collection of data from CERN, and distribution of data to U.S. ATLAS users at remote sites.

2.3.1.2.8 Production Software

Software supporting large-scale simulation, reconstruction and analysis production jobs, and relevant server software.

2.3.1.3 System and User Support

2.3.1.3.6 Documentation

Support for the preparation, access to, management of and distribution of documentation for ATLAS software and the detector.

2.3.1.3.7 Code Management and Distribution Tools

Software tools to support code versioning, building releases and distribution.

2.3.1.3.8 Software Development Tools

Tools for designing, developing and testing software.

2.3.1.3.9 System Administration, Monitoring Tools

Tools for administration and monitoring of the regional center – accounts, usage, etc.

2.3.1.3.10 User Help Desk

Personnel and tools to support consultancy

2.3.1.3.11 Facility R&D, Prototyping, Design and Integration

2.3.1.4 Maintenance

2.3.1.4.1 Hardware maintenance

Maintenance contracts, etc for center hardware

2.3.1.4.2 Software maintenance

Cost of licensing and maintenance of regional center software

2.3.1.4.3 Systems operation

Cost of regional center operation, includes media costs, operations staff

2.3.1.4.4 Infrastructure support

Management staff, building and site expenses.

2.3.2 Remote (Tier 2,3) analysis centers

2.3.2.1 Hardware

2.3.2.1.1 Development and Test Systems
Support software platforms for core and detector specific simulation and reconstruction software.

2.3.2.1.2 Simulation and reconstruction
Simulation and reconstruction hardware associated with CPU intensive tasks at remote analysis centers.

2.3.2.1.3 Data storage
Tape and disk hardware for storage of simulated and actual data.

2.3.2.1.4 Information servers
Web and e-mail servers at remote sites

2.3.2.1.5 Desktop systems
Desktop computing resources to users at remote sites

2.3.2.1.6 Local Area Network

2.3.2.2 Software
Software particular to remote sites.

2.3.2.2.1 Database and database management
Purchase and maintenance of database systems at remote sites.

2.3.2.2.2 Simulation Software
Support of simulation software at remote sites.

2.3.2.2.3 Data and Physics Analysis Software
Support of reconstruction and analysis software for U.S. users at remote sites

2.3.2.3 System and User Support

2.3.2.3.1 Collaborative tools
Collaborative tools that enable the linkage of remote sites and support of the collaboration over long distances.

2.3.2.3.2 Code Management and Distribution Tools
Software tools to support code versioning, building releases and distribution

2.3.2.3.3 Software Development Tools
Tools for designing, developing and testing software

2.3.2.3.4 System Administration, Monitoring
Administration and monitoring of remote sites.

2.3.2.4 Maintenance at Remote Sites

2.3.2.4.1 Hardware maintenance
Maintenance contracts, etc. for hardware at remote sites

2.3.2.4.2 Software maintenance
Cost of licensing and maintenance of software at remote sites

2.3.2.4.3 Systems operations
Cost of remote site operations, including media costs, operations staff

2.3.2.4.4 Infrastructure support
Management staff, building and site expenses

2.3.3 World Wide Networking

2.3.3.1 WAN R&D, modeling and monitoring

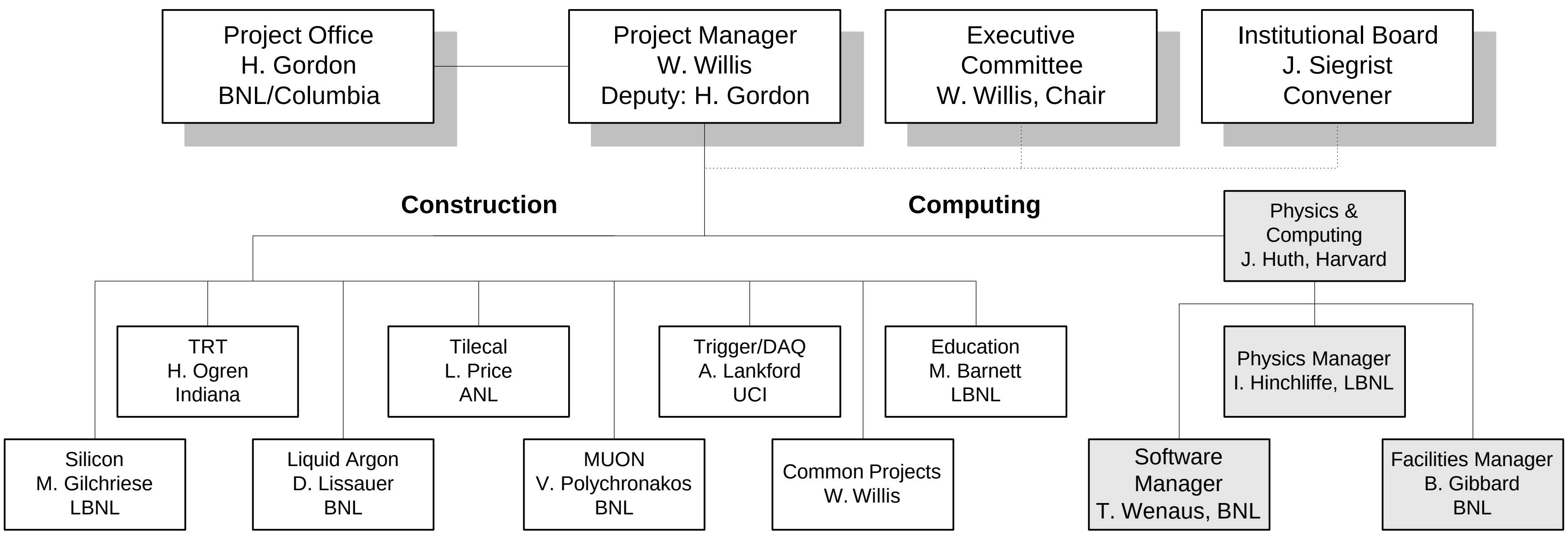
2.3.3.2 Domestic Networking

2.3.3.3 International Networking
Includes hardware, leasing, infrastructure and operations of networking capabilities to CERN, for data transfer, collaboration needs (video conferencing), server links, etc. Cost of shipping tapes from CERN to U.S. can be considered “networking” – broadly considered.

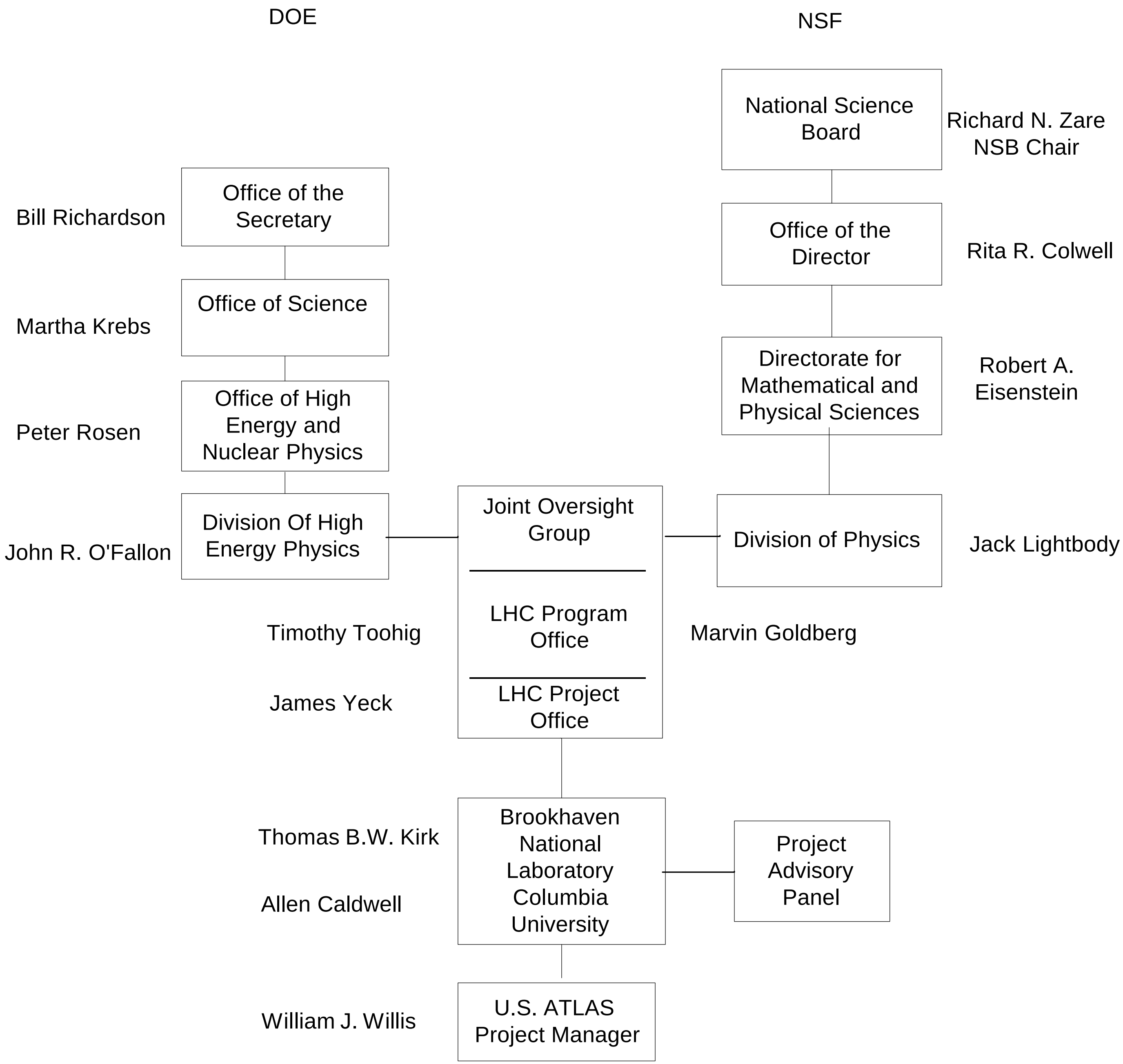
2.3.4 MONARC
Analysis of networked architectures for ATLAS computing

	99 FTE	$k	00 FTE	$k	01 FTE	$k	02 FTE	$k	03 FTE	$k	04 FTE	$k	05 FTE	$k	06 FTE	$k	Total FTE	Total $k
~~Core~~																		
Control	0.6	120	3.1	620	5.3	1060	5.3	1060	4	800	3	600	2	400	2	400	25.3	5060
Data management	0.7	140	3	600	5	1000	6	1200	7	1400	7	1400	7	1400	7	1400	42.7	8540
Subtotal	1.3	260	6.1	1220	10.3	2060	11.3	2260	11	2200	10	2000	9	1800	9	1800	68	13600
Contingency	1		1		1.4		1.4		1.4		1.4		1.4		1.4			
Subtotal w/ cont.		260		1220		2884		3164		3080		2800		2520		2520		18448
																	0	0
~~Sim/recon~~																	0	0
Inner Detector			0	0	0	0	1	150	2	300	2	300	2	300	2	300	9	1350
TRT			0	0	1	150	1	150	2	300	2	300	2	300	2	300	10	1500
E-Cal	0.5	75	1	150	1	150	2	300	2	300	2	300	2	300	2	300	12.5	1875
Tilecal			1	150	1	150	2	300	2	300	2	300	2	300	2	300	12	1800
Muons			0	0	1	150	2	300	2	300	2	300	2	300	2	300	11	1650
Trigger/DAQ			0	0	0	0	1	150	2	300	2	300	2	300	2	300	9	1350
Subtotal		75	2	300	4	600	9	1350	12	1800	12	1800	12	1800	12	1800	63	9525
Contingency	1		1		1		1		1		1		1		1			
Subtotal w/ cont.		75		300		600		1350		1800		1800		1800		1800		9525
~~Physics~~																		
Event Generator					1	140	1	140	1	140	1	140	1	140	1	140	6	840
Contingency					1		1		1		1		1		1			
Subtotal w/ cont.						140		140		140		140		140		140		840
~~Training, Support~~																		
Training		20		40		30		30		30		30		30		30		240
Support			1	150	1	150	1	150	1	150	1	150	1	150	1	150	7	1050
Contingency		1		1		1		1		1		1		1		1		
Subtotal w/ cont.		20		190		180		180		180		180		180		180		1290
																	0	0
~~Appl. Subtotal~~	1.3	355	9.1	1710	16.3	3804	22.3	4834	25	5200	24	4920	23	4640	23	4640	144	30103
																	0	0
~~Facilities~~																	0	0
Tier 1 Hardware		110	0	220	0	560	0	590	0	910	0	1650	0	2450	0	2130	0	8620
Tier 1 Staffing	1	100	4	560	8	1120	11	1540	16	2240	19	2660	25	3500	25	3500	109	15220
Tier 2 Staffing	0	0	0	0	1	140	3	420	8	1120	12	1680	12	1680	12	1680	48	6720
Tier 2 Hardware			0	0	0	190	0	380	0	1150	0	1380	0	2580	0	2110	0	7790
Tier 2 Subtotal			0	0	1	330	3	800	8	2270	12	3060	12	4260	12	3790	48	14510
Contingency	1		1		1.4		1.4		1.4		1.4		1.4		1.4			
Tier 2 +Cont.		0		0		462		1120		3178		4284		5964		5306		20314
Networking		0	0	0	0	160	0	260	0	710	0	790	0	1060	0	820	0	3800
Subtotal no cont.	1	210	4	780	9	2170	14	3190	24	6130	31	8160	37	11270	37	10240	157	42150
																	0	0
~~Tier 1 + Network Sub~~	2.3	210	13.1	780	24.3	1840	33.3	2390	41	3860	43	5100	48	7010	48	6450	253	27640
~~Contingency~~	1		1		1.4		1.4		1.4		1.4		1.4		1.4			
~~Tier 1+Net. Sub+Cont~~		210		780		2576		3346		5404		7140		9814		9030		
~~Total (w/ Tier 2)~~	2.3	210	13.1	780	25.3	3038	36.3	4466	49	8582	55	11424	60	15778	60	14336	301	58614
~~Multipliers~~																		
Core FTE to $	200																	
Sim/recon FTE to $	150																	
Facility FTE to $	140																	
FY Multipliers		0.98	1	1	1	1.025	1	1.0517	1	1.0811	1	1.114	1	1.1436	1	1.1779	1	
Application Sub		348		1710		3899		5084		5622		5481		5306		5465		32915
Tier 2 Facilities		0	0	0	1	474	3	1178	8	3436	12	4772	12	6820	12	6250		22978
Tier 1 Facilities		206		780		2640		3519		5842		7954		11223		10636		42801
Totals		554		2490		7013		9781		14900		18207		23350		22352		98694

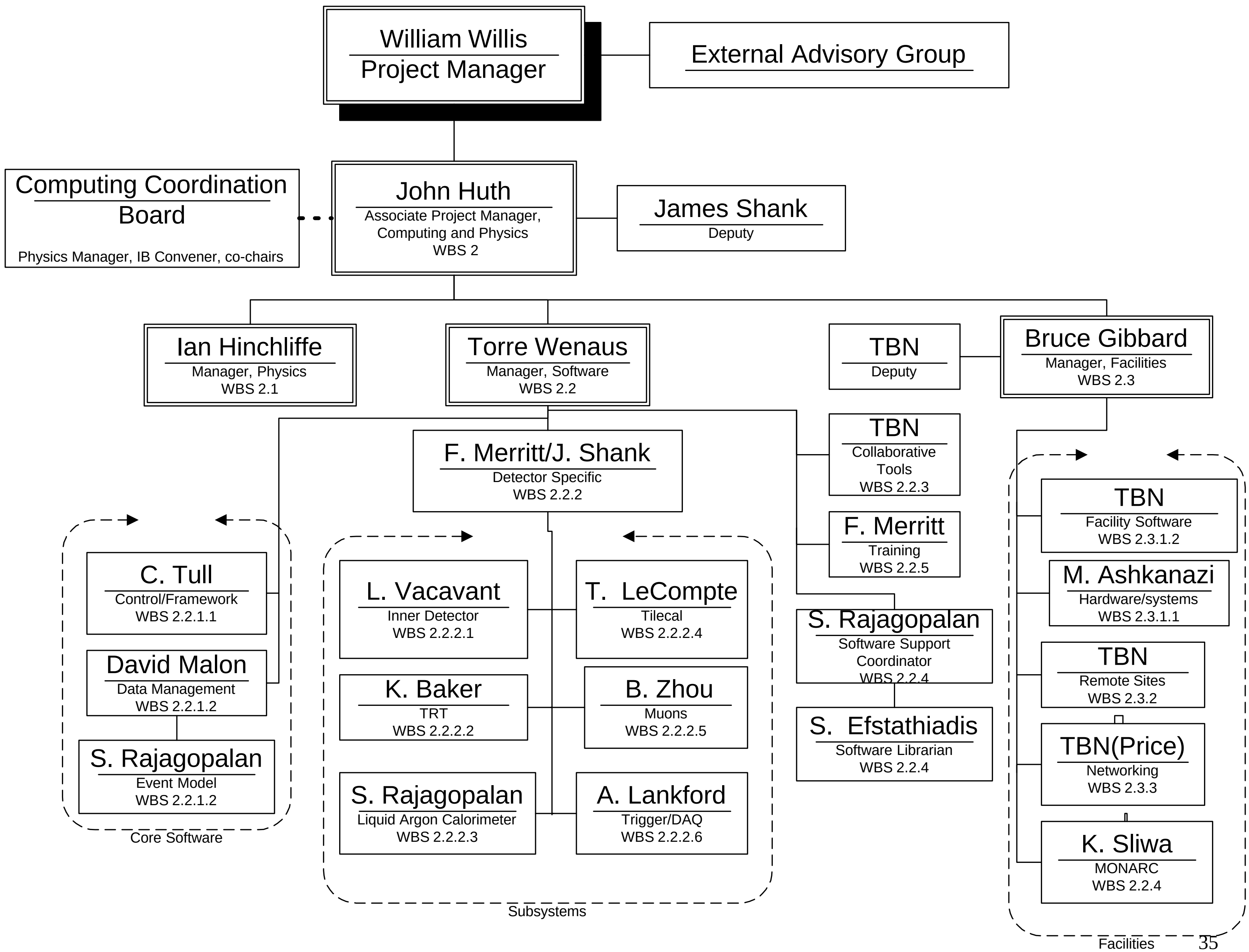
Apppendix 2: U.S. ATLAS Organization



Appendix 3: DOE-NSF-U.S. ATLAS Organization



Appendix 4: Management Structure of the U.S. ATLAS Physics and Computing Project



Appendix 5: U.S. ATLAS Major Project Milestones (Level 2)

Subsystem	Schedule Designator	Description	Baseline Schedule	Forecast (F) / Actual (A) Date
Software Projects (2.2)	SP L2/1	Prototype release of reconstruction framework	01-May-00	01-May-00
	SP L2/2	Alpha release design review	01-Jun-00	01-Jun-00
	SP L2/3	Alpha release of control framework (basic functionality)	01-Sep-00	01-Sep-00
	SP L2/4	Freeze beta architecture and database interface	01-Mar-00	01-Mar-00
	SP L2/5	Control framework first production release	01-Jan-01	01-Jan-01
	SP L2/6	Full function release design review	01-Jul-01	01-Jul-01
	SP L2/7	Full function release of control framework (general use)	01-Oct-01	01-Oct-01
	SP L2/8	Freeze distributed architecture	01-Apr-02	01-Apr-02
	SP L2/9	Control framework V1 design review	01-Jul-02	01-Jul-02
	SP L2/10	Control framework V2 design review	01-Oct-02	01-Oct-02
	SP L2/11	Release of database infrastructure in support of control framework's production release	01-Oct-02	01-Oct-02
	SP L2/12	Control framework second production release (post-MDC)	01-May-04	01-May-04
Facilities (2.3)	FAC L2/1	Selection of 1st Tier 2 site	01-Oct-00	01-Oct-00
	FAC L2/1	Procure dedicate Automated Tape Library (ALT)	01-Jun-01	01-Jun-01
	FAC L2/2	Demo Tier 2 transparent use of Tier 1 ATL	01-Jan-02	01-Jan-02
	FAC L2/3	Establish dedicated Tier 1 / CERN link	01-Jan-02	01-Jan-02
	FAC L2/4	Select remaining (4) Tier 2 sites	01-Jan-03	01-Jan-03
	FAC L2/5	Mock Data Challenge I (25% turn-on capacity)	01-May-03	01-May-03
	FAC L2/6	Final commit to HSM	01-Oct-03	01-Oct-03
	FAC L2/7	Demo full hierarchy transparent operation	01-Apr-04	01-Apr-04
	FAC L2/8	Mock Data Challenge II (50% turn-on capacity)	01-Jun-04	01-Jun-04
	FAC L2/9	Achieve turn-on capacities	01-Jan-05	01-Jan-05